NOTES ON SOME POINTS CONNECTED WITH THE PROGRESS OF ASTRONOMY DURING THE PAST YEAR.

Discovery of Minor Planets in 1902.

Fifty new planets were discovered during the past year, as follows :

Provisional Designation.	Permanent Number.	Name.	Date of Discovery, 1902.	Discoverer.	Place of Discovery.
HP	481	...	Feb. 12	Carnera	Heidelberg
HR	...	...	Mar. 3	Wolf	,,
HT	482	...	,, 3	,,	,,
HU	483	...	,, 4	,,	,,
HW	...	...	,, 6	,,	,,
HX	484	...	May 7	,,	,,
HY	...	...	,, 7	,,	,,
HZ	485	...	,, 7	Carnera	,,
JA	...	...	,, 7	,,	,,
JB	486	...	,, 7	,,	,,
JC	...	...	,, ,,	,,	,,
JD	...	...	,, 11	,,	,,
JF	...	...	(1899 June 9)	Pulfrich	,,
JG	...	...	1902 June 26	Wolf	,,
JL	487	Venetia	July 9	Carnera	,,
JM	...	...	Sept. 2	,,	,,
JO	...	...	,, 3	Wolf	,,
JP	...	...	,, 3	,,	,,
JQ	...	...	,, 3	,,	,,
JR	...	...	,, 3	,,	,,
JS	...	...	,, 7	,,	,,
JT	...	...	,, 26	Carnera	,,
JV	...	...	Oct. 7	Wolf	,,
JW	...	...	,, 7	,,	,,
JX	...	..	,, 7	,,	,,
JY	...	...	,, 24	,,	,,

Provisional Designation.	Permanent Number.	Name.	Date of Discovery, 1902.	Discoverer.	Place of Discovery.
JZ	...	...	Oct. 24	Wolf	Heidelberg
KA	...	...	,, 25	Dugan	,,
KB	...	...	,, 25	Wolf	,,
KC	...	...	,, 25	,,	,,
KD	...	...	,, 25	,,	,,
KF	...	...	,, 25	,,	,,
KG	...	...	,, 25	,,	,,
KH	...	...	,, 25	,,	,,
KJ	...	...	Nov. 4	Dugan	,,
KL	...	...	Oct. 25	Wolf	,,
KM	...	...	Nov. 20	,,	,,
KN	...	...	,, 20	,,	,,
KO	...	...	,, 21	,,	,,
KP	...	...	,, 21	,,	,,
KQ	...	...	,, 21	,,	,,
KR	...	...	,, 21	,,	,,
KS	...	...	,, 21	,,	,,
KT	...	...	,, 21	,,	,,
KU	...	...	Dec. 2	Charlois	Nice
KV	...	...	,, 23	Wolf	Heidelberg
KW	...	...	,, 24	,,	,,
KX	...	...	,, 24	,,	,,
KY	...	...	,, 24	,,	,,
KZ	...	...	,, 24	,,	,,

The number of discoveries is far the largest on record in any year, but it is possible that some of the recent discoveries may prove to be planets already known. The planets provisionally designated by the following letters proved to be identical with known planets :—HL with 358 *Apollonia*, HO with 458, HQ with 93 *Minerva*, HS with 359 *Georgia*, HV with 72 *Feronia*, JH with 486, JJ with 451 *Patientia*, JK (probably) with 470 *Kilia*, JN with 311 *Claudia*, JU with 106 *Dione*, KE with 19 *Fortuna*, KK with GT, each being probably identical with (156) *Xanthippe*.

Planet GL, unnumbered at the date of the last Report, has since received the permanent number 480.

The following planets do not receive permanent numbers, not having been sufficiently observed :—HM, HR, HW, HY, JA, JC, JD, JF, JG, JM. The discovery of JE was cancelled as erroneous.

The discovery of JF is a triumph for the stereo-comparator, Dr. Pulfrich having detected the planet by its aid on a plate taken three years earlier, on which the trail had escaped detection.

The following planets have been named :—359 *Georgia*, 472 *Roma*, 475 *Ocllo*, 477 *Italia*, 478 *Tergeste*.

The interesting planet *Ocllo*, whose orbit is the most eccentric of the whole family, has been recovered at the present opposition, being of the fourteenth magnitude.

Several observations of *Eros* were obtained in Europe and America a few months ago ; during its opposition it is in such high south declination that it is out of reach of northern observers. A. C. D. C.

The Comets of 1902.

The comet history of the year is practically limited to the observations of four comets.

Comet 1902 *a* was discovered by Mr. Brooks, of Geneva, New York, on April 14. Situated in the constellation *Pegasus*, observations were possible only in the morning sky, and the rapidity with which the comet approached the Sun considerably curtailed these. It is to be feared that the comet was insufficiently observed, and that the true form of the orbit will remain doubtful. The earlier course of the comet, prior to discovery, had been through *Cygnus*, where the opportunities for detecting it, if more favourable in position, were discounted by the greater faintness of the object. This comet is reported to have had a tail some twenty minutes long, and in a photograph of comparatively short exposure taken by Dr. Max Wolf this tail is shown as a fan-like appendage with the southern concave border noticeably brighter than the northern. There is scarcely any recognisable nucleus, but the object is very feebly impressed on the photographic plate.

The second comet (1902 *b*) was discovered by Mr. Perrine, of the Lick Observatory, on August 31, and independently by M. Borrelly at Marseilles, a night or two later. It was described by Mr. Perrine as a slightly elongated nebulosity, four minutes in diameter, with a well defined nucleus and some evidence of a tail. This object, found in *Perseus* and travelling northwards, was easily followed, and its continually increasing brilliancy attracted general attention. A rapid movement to the south in October carried it into the southern hemisphere, where it has since been observed by Mr. Tebbutt and others. It is not impossible that the comet will be seen again in these latitudes in February or March, when it will pass through *Canis Major*, and should have a brilliancy approximately equal to that of the time of discovery. The observations are well represented by a parabola, but an interesting feature in the orbit is the near approach it makes to that of *Mercury*. The comet was separated from the planet, when nearest, by about 0·02 R, a close approach, but scarcely sufficient to disturb noticeably the parabolic velocity.

Numerous observations have been made of the physical appearance of the comet, and many photographs have been taken. For the general results of this kind of observation it will be sufficient to refer to the illustrated paper communicated by the Astronomer Royal to the November number of the *Monthly Notices*, in which number is also given an account by Dr. Max Wolf of an attempt to obtain a stereoscopic effect by exposing plates at slightly different times.

The third comet, known as *c*, was discovered previous to that of Perrine, and passed its perihelion some months earlier ; but, owing to an unfortunate circumstance, intelligence of the discovery did not reach Europe till September. On July 22, Mr. Grigg, of Thames, New Zealand, suspected a comet in the constellation *Leo*. Examination on subsequent evenings confirmed this suspicion, and he gave notice to Mr. Baracchi and others. Mr. Baracchi did not receive information till August 6, and made careful search over a wide area at the earliest possible opportunity, but without success. He therefore awaited confirmation or fresh information from some other source ; but unfortunately the comet was seen only by Mr. Grigg. The observations are rough, but Mr. Grigg has computed a set of elements from his data, which show that the comet when at its brightest must have passed through *Taurus* and *Gemini* in the preceding June. In these constellations it was scarcely likely that the comet would have been seen in northern latitudes. It was decreasing in brilliancy when seen by Mr. Grigg at the end of July, and under the adverse circumstance of doubtful position and fading illumination it was scarcely likely that it would be recovered when intelligence reached this country.

The last comet discovery of the year was made by M. Giacobini, of Nice, to whom we have been indebted for the detection of several faint comets. This one is also a faint object, but is particularly interesting on account of its great perihelion distance (2·8 R). With the single exception of the comet of 1729 there is no instance of a comet remaining at so great distance from the Sun. Necessarily the motion is slow, and any variation in brilliancy scarcely perceptible. It will not reach its perihelion till next March, and observations will be possible for some time to come. An accurate ephemeris has been prepared by Dr. Ristenpart, especially adapted to a plan which he has suggested as desirable for the reduction of extra-meridional observations of comets. Since the suggestion offers some advantages, and is likely to be gradually adopted, too wide a publicity cannot be given to the proposed innovation, in order to avoid subsequent confusion in the definitive determination of orbits.

Some other comets have passed through perihelion without being seen. Among these may be mentioned Swift's comet of 1895, and another known as Tempel$_3$-Swift. The former of these was probably in perihelion in November, and observations might have been made in the summer. But the conditions for observing were not so favourable as in 1895, and the extreme faintness of the comet has baffled the search. The second is the comet discovered by Tempel in 1869, and re-discovered by Swift in 1880. It was seen in 1891 by Barnard. An ephemeris for this apparition was prepared by M. Bossert, but apparently without success. August seemed a fairly favourable time to recover it, and in this month Dr. Max Wolf applied the photographic method to secure its detection. Up to the present it has not been seen.

Mr. Lindemann's offer to subsidise inquiries in the matter of comet orbits whose definitive elements have not been determined has been effective, and several sets of elements of ancient comets have been added to our catalogues, mainly through his generosity.

Progress of Meteoric Astronomy in 1902.

January Meteors.—On January 2, during intermittent watches amounting to two hours, Mr. T. W. Backhouse, at Sunderland, observed 24 meteors, including 18 *Quadrantids.* On the following night, in 1¾ hour, 10 meteors, including 5 *Quadrantids*, were seen. On January 2, $9^h\ 52^m$ to $10^h\ 37^m$, Mr. J. H. Bridger, at Farnborough, counted 6 meteors (3 from *Quadrans*).

April Meteors.—The *Lyrids* appear to have escaped observation, the moon being full on April 22.

July Meteors.—Mr. R. M. Dole, Ogunquit, Me., U.S.A., watched for the *Aquarids* on July 30, 8^h to $14^h\ 45^m$ and found the shower in rather strong evidence, 62 of its meteors being counted in the 6¾ hours over which observations extended. Between 12^h and $14^h\ 45^m$ the rate of apparition was 1 every 3⅓ minutes. The meteors were mostly slow and faint, with long paths.

August Meteors.—There was little interference from moonlight, but cloudy weather was very prevalent over the west of England, though the sky seems to have been generally favourable in the eastern counties. At the Royal Observatory, Greenwich, the following results were obtained :

Date.	Time of Watch. h h	Duration.	Observers.	No. of Meteors.	No. of Perseids.
August 9	10 to 15	5	3	28	22
10	9 „ 16	7	3	106	94
11	9½ „ 13½	4	3	74	67
12	9 „ 16	7	3	101	92
13	10 „ 12	2	1	23	21
Totals, five nights		25	...	332	296

Mr. G. M. Knight, London, watched the sky on seven nights between July 31 and August 10, and counted 539 meteors. Of these 239 were observed on August 10 in $3\frac{3}{4}$ hours.

Mr. A. King, Leicester, obtained observations between July 27 and August 12, and during watches extending over $11\frac{1}{2}$ hours recorded 98 meteors (32 *Perseids*). "The maximum seemed to occur on August 11 or 12, probably the latter night."

Mr. Backhouse, Sunderland, saw 33 *Perseids* in about $1\frac{1}{4}$ hour on August 11, between 11^{h} and $13^{h}\,50^{m}$.

At Bristol, owing to unusually inclement weather, the writer could only secure brief observations on five nights between August 2 and 14, when 53 meteors were seen in about 4 hours' watching.

Mr. C. P. Olivier, University of Virginia, U.S.A., watched on August 10, between $12^{h}\,33^{m}$ and $16^{h}\,8^{m}$, and counted 70 meteors (42 *Perseids*). On August 11, between $13^{h}\,38^{m}$ and $16^{h}\,8^{m}$, there were 102 meteors (76 *Perseids*). Rate of *Perseids*, August 10, 1 in 5 minutes; August 11, 1 in 1·9 minute.

Mr. Dole, Ogunquit, Me., describes the *Perseid* display as "very active" in 1902, with maximum on August 12, $14^{h}\,30^{m}$. He recorded the following numbers :

	h m		h m	
August 12	11 20	to	15 21	261 *Perseids*
„ 13	11 40	„	15 18	176 „

Reports have been received from a considerable number of other stations, and they prove that the *Perseid* shower was a fairly rich one—probably stronger than the average—that the maximum occurred on the morning of August 13, and that the centre of radiation exhibited its normal displacement to the E.N.E., as observed on successive nights. The following are some determinations of the radiant position :

Date.	Radiant. α	δ	Meteors.	
1902.	°	°		
August 1–3	37	+55	26	G. M. Knight
3	$40\frac{1}{2}$	+54	6	C. L. Brook.
4–5	40	$+55\frac{1}{2}$	12	G. M. Knight.
8	$42\frac{1}{2}$	$+54\frac{1}{2}$	11	H. J. Townshend.
8–10	44	+53	7	C. L. Brook.
9	38	$+56\frac{1}{2}$	...	Herr Koss.
10	39·5	$+56\frac{3}{4}$	42	C. P. Olivier.
10	44	+58	9	A. King.
10	$44\frac{1}{2}$	+57	43	G. M. Knight.
10	45	$+58\frac{1}{2}$	15	W. F. D.
10	$45\frac{1}{2}$	$+54\frac{1}{2}$	...	Herr Koss.
11	$46\frac{3}{4}$	$+56\frac{3}{4}$	76	C. P. Olivier.
12	47	$+58\frac{1}{2}$	9	W. F. D.
48	48	$+56\frac{1}{2}$	6	A. King.

Professor J. Lycova, of the Jourieu Observatory, Dorpat, photographed 7 meteor trails on 1901 August 11, of which 5 were *Perseids*, indicating the radiant at α 43° 55′·8, δ +57° 10′·3. On August 12 he found the radiant evidently slightly east of that position.

Meteoric Showers in September.—During the first week of the month 116 meteors were seen at Bristol during 18 hours of observation. Two pretty conspicuous showers of *Polarids* were seen, and there were active displays of η *Aurigids* and β *Triangulids.*

October Meteors.—Cloudy weather and the light of a full Moon appear to have effaced the *Orionid* shower.

November Meteors.—Though the *Leonids* of the three years 1898, 1899, and 1900 disappointed every eye, the hope was encouraged that, as the shower had exhibited a decided intensification in 1901, there would be a pretty strong recurrence of it in 1902. Moreover the latter year was suggested as favourable to its return, owing to the fact that brilliant displays had been witnessed in 902, 1002, 1202, and 1602, and that exactly three revolutions of the swarm were performed in a century. The meteors were therefore looked for in 1902 November with almost equal enthusiasm to that shown in previous years, though the Moon most inopportunely became full at the very time when the maximum was expected. Other conditions proved unfavourable; overcast skies just at the important period appear to have veiled the meteors from the majority of observers both in England and America. At stations, however, where suitable views could be obtained there was no sign of an abundant display; only a few *Leonids* could be seen interspersed with the ordinary "sporadic" shooting stars. Reports from sixty stations in America affirm that practically no shower of *Leonids* was seen. Before sunrise on the morning of November 13 the *Leonid* radiant seemed quiescent or nearly so, as observed at Bristol and by Mr. A. King at Leicester. Cloudy nights then intervened, but on November 18, between 2 and 3 A.M., some 8 or 10 meteors were seen by Mr. J. R. Henry, of Dublin, "flashing from *Leo*," but their identity as true *Leonids* is somewhat questionable, though the date is certainly not too late for belated members of the stream. On November 14, from midnight to 15^{h} 30^{m} E.S.T., Mr. Wendell and assistants at Cambridge, Mass., watched a sky partly involved in cloud and haze and only counted 5 meteors. At Mexico City, Mexico, Mr. L. G. Léon maintained a look-out on November 14, 2 to 4 A.M., and states that in the beautifully clear, moonlit sky he recorded 18 *Leonids.* It is obvious, however, from the chart of tracks published in *Popular Astronomy* (1903 January) that very few of these meteors were genuine *Leonids.* It is often difficult—sometimes impossible—to identify the latter objects from the meteors of contemporary showers directed from radiants near the Sickle of *Leo.*

Of the *Andromedids* (November 23) and *Geminids* (December 10–12) little or nothing appears to have been observed in 1902. The year generally was unfavourable for meteoric observation, owing to the unusual amount of cloud that prevailed and to the fact that bright moonlight virtually overpowered several of the principal showers.

The following is a list of real paths of bright meteors observed in England during the past year :

Date.	G.M.T.	Brightness.	Height at First. Miles.	Height at End. Miles.	Length of Path. Miles.	Velocity per Sec. Miles.	Radiant Point. α	Radiant Point. δ	Observers.
1902.	h m						°	°	
May 27	12 22	$1\frac{1}{2}$ − ♀	63	39	120	24	282	− 24	2
July 13	10 30	= ☽	89	51	51	26	315	+ 31	60
27	11 36	♃	71	52	45	33	351	+ 3	2
Aug. 21	14 2	= ☽	65	33	611	15	283	− $10\frac{1}{2}$	20
Sept. 25	7 34	> ♀	88	57	34	> 100	254	+ 46	2
Oct. 15	7 47	♀	62	54	130	37	150	+ 43	3
Dec 2	7 20	> ♀	63	42	31	14	43	+ 22	2

A fine meteor was seen by Professor A. S. Herschel, Captain P. B. Molesworth, and other observers on July 15, 9^h 32^m. The former determined its radiant at 236°–13°, height 60 to 38 miles, observed path 51 miles, and velocity 17 miles per second.

Comparatively few new determinations of radiants have been obtained during the year. While watching the *Perseids* on August 10 Mr. Knight recorded 15 *β Andromedids* from a centre at 19° + $29\frac{1}{2}$°. The following radiants were the principal ones derived from observations at Bristol, July to September. In some cases a few meteors recorded in previous years were combined with those seen in 1902, in order to strengthen the positions and ascertain them more accurately :

Year.	Date.	Radiant. α	Radiant. δ	Meteors.	Notes.
		°	°		
1885–1902	July 5–13	22	+ 22	7	Swift, streaks.
1877–1902	July 7–9	10	+ $45\frac{1}{2}$	6	Swift, streaks. Very early Perseids.
1885–1902	July 9–21	30	+ 36	7	Swift, streaks.
1902	Aug. 24–Sept. 7	74	+ 41	7	Swift, streaks.
1885–1902	Aug. 25–Sept. 16	353	− 11	15	Slow, long paths.
1902	Aug. 26–Sept. 7	337	+ $81\frac{1}{2}$	10	Swift.
1902	Sept. 3–7	118	+ $83\frac{1}{2}$	8	Swift.
1902	Sept. 3–7	30	+ 37	8	Swift, short.
1877	Sept. 7–25	100	+ 13	10	Swift, streaks.
1900–1902	Sept. 29–Oct. 2	347	+ 3	13	Very slow.

Detonating Fireball observed in Sunshine.—At 10^h 55^m G.M.T. on the morning of April 10, when the Sun was shining and the air still, strange sounds of a very loud and unusual character were heard over East Tyrone, Ireland, by many persons, who were much alarmed and considered them the accompaniment of an earthquake. The Rev. E. F. Campbell says : "The sound seemed to be very deep in the heavens ; to the east it appeared to be far above thunder distance and about half as loud. It lasted from thirty to sixty seconds, and I can only describe it as being like the whirring of a very large motor with a deep tone." Another observer at Market Hill, Co. Armagh, describes it as "a great rumbling sound which lasted about eight seconds. It was a full round booming pervaded by a regular wavy rumbling. A boy eleven years of age, working in a garden, when he heard the noise ran away and said the ground was shaking." At about the same time (probably a few minutes previously) a pear-shaped fireball with a tail was seen by Mrs. Martin, of Dunsink, Co. Dublin, passing overhead and falling low towards the north horizon. A singular feature of the event is that a rushing noise above her head attracted Mrs. Martin's attention to the meteor, and that this sound continued to be distinctly heard during the three or four seconds occupied in the descent of the object. It was also seen by Master R. Fitzmaurice, of Carlow, and he says it flashed into sight in the N.E. and left a long train behind. The radiant point of the meteor was probably in *Aquarius* or *Pisces* in the southern sky, and the disruption of the object must have occurred comparatively near the Earth's surface in the district of Dungannon and Lough Neagh, though none of the fragments appear to have been found.

Observed Fall of a Meteorite.—The most important meteoric event of the year occurred on September 13, $10^h\ 55^m$ G.M.T., when a meteorite fell at Crosshill, near Crumlin, and about twelve miles west of Belfast, Ireland. The stone has been acquired for the British Museum, and the explanatory label * attached to the case containing it gives all the essential particulars of the event in a concise form :

"On Saturday, September 13, at 10.30 A.M.,† a loud noise as of explosions was heard at various places on the western side of Belfast ; among others, Antrim, Crumlin, Lisburn, Moira, Lurgan, and Pointzpass. Of these Antrim and Pointzpass are thirty miles apart. One observer at Crosshill at first thought that the noise was due to the bursting of the boiler in the mill at Crumlin a mile away ; another thought that a train had run off the line. Two or three distinct detonations were heard. The detonations were followed by another sound likened to that made by escaping steam ; other observers describe it as a rattling noise, similar to that made by a reaping machine, but much louder. Two men, Walker and Montgomery, were at the time stacking hay at Crosshill. The former was on the top of the nearly finished stack, and immediately after hearing the noise saw from this lofty point of view something whirl into the adjacent corn field.* The exact spot was indicated by a cloud of dust which at once rose above the standing corn. It was only twenty yards distant from a tree on which a third man, Adams, was at work gathering apples. It was found that a deep hole had been made in the soil. Adams went for a spade, and within a quarter of an hour of the fall extracted from the hole a black, dense stone, which had penetrated to a depth of eighteen inches and had then been stopped by a much larger stone lying in the soil. The black stone was hot when extracted, and is said to have been warm even an hour later. Before being cut to show its interior the stone weighed 9 lbs. $5\frac{1}{2}$ oz., and was $7\frac{1}{2}$ inches long, $6\frac{1}{2}$ inches wide, and $3\frac{1}{2}$ inches thick. The stone consists of a grey material covered with a thin black crust. Such a crust is always found on meteoric stones. The surface of the meteorite, owing to the immense compression of the air in front of the swiftly moving body, becomes hot enough to be luminous, and is well scorched. The pressure of the air on the front of the meteorite continues to increase until at last the material yields and breaks up with violent detonation. If the fragments thus produced are still travelling with great speed the new surfaces likewise become encrusted, though not as much as the earlier ones. The form of the Crumlin stone is distinctly fragmental, and one large surface of fracture well illustrates this stage of later scorching. The meteorite chiefly consists of stony material, probably a mixture of olivine and enstatite ; through it are dispersed grains of a metallic alloy of iron and nickel. Here and there are small nodules of the bronze-coloured mineral troilite, a compound of iron and sulphur not found as a native terrestrial product."

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* Written by Mr. L. Fletcher, F.R.S. A very interesting and illustrated description by the same author appeared in *Nature*, 1902 October 9.

† Local time.

The stone has not yet been submitted to chemical analysis.

Previous and most recent falls of meteorites occurred in the United Kingdom as follows :—

1881 March 14. Stone $3\frac{1}{2}$ lbs. in weight fell on a railway siding near Middlesborough, Yorks.

1876 April 20. Mass of iron $7\frac{3}{4}$ lbs. in weight fell at Rowton, near Wellington, Shropshire (*Monthly Notices*, xxxvi. pp. 205–6).

Great Meteorite of Sinaloa, Mexico.—The *American Geologist* for 1902 October contains a paper by H. A. Ward, of Rochester, N.Y., descriptive of the above object. He visited Bacubirito, an old mining town in the Rio Sinaloa, in lat. 26° N. and long. 107° W., and the great meteorite was located about seven miles south of that place on a farm named Ranchito. Its appearance was that of a long monstrous boulder of black iron, which seems to be still burrowing to hide itself from the upper world. The earth was removed from round the meteorite, and its dimensions were then ascertained to be: length, 13 ft. 1 in; width, 6 ft. 2 in; thickness, 5 ft. 4 in. Mr. Ward concluded that this object is probably the largest of its kind in existence, and estimated its weight as approximately fifty tons. The application of acid brought out the Widmanstatten figures in a beautiful manner. Professor J. E. Whitfield made an analysis of the meteor as follows:

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* The meteorite fell on the farm of Mr. Andrew Walker, and he states that it must have descended perpendicularly, or nearly so, according to the shape of the hole, and the corn standing round was not beaten down in any way.

Specific gravity ... ... 7·69

Iron... ...	88·944	Sulphur ...	0·005
Nickel ...	6·979	Phosphorus ...	0·154
Cobalt ...	0·211	Silicon ...	trace

New Determinations of Radiants.—Professor D. Eginitis, of Athens, gives a list of radiants in *Astronomische Nachrichten*, 3815, two of which are probably new. He mentions that in 1900 and 1901 the maximum of the *Perseids* occurred on August 11. M. Eginitis specially remarks upon the fact that the principal showers apparently exhibit multiple radiants. It will be remembered that Mr. J. W. C. Herschel attributed a similar character to the *Lyrid* shower of 1901 (*Monthly Notices*, lix. p. 564). In fact, all regular meteoric observers have met with instances of compound radiation. This feature obviously requires further investigation, but it may well be regarded as a necessary outcome of the materials employed. Observational inaccuracies, erratic flights of perturbed meteors, and mistakes in apportioning meteors to their various radiants, must sometimes induce indefinite radiation, and the path intersections will indicate a number of contiguous foci. But careful observations of the same showers in several years will prove that the latter are not due to concentric meteor streams, but are rather an effect of the accidental grouping of positions depending upon uncertain data.

Meteoric Section of the British Astronomical Association.—Eleven annual reports have been published (the last in 1902 April), and they contain a mass of useful information in the form of tables and descriptive matter, illustrative of and resulting from meteoric work since 1890. The twelfth report is on the eve of publication by the present director, Mr. W. E. Besley.

W. F. D.

Solar Activity in 1902.

Although the solar activity in 1902, as evidenced by the numbers and areas of Sun-spots, has not been great, there can be no doubt that the actual minimum is past, and that a new cycle has distinctly begun. This is clearly seen in the diminution of days without spots, the 81 per cent. of 1901 having fallen to about 72 per cent. in 1902. The percentage numbers of spotless days from the Greenwich records for 1898, 1899, and 1900 were 13·5, 33·8, and 53·1 respectively; so that, in spite of this improvement, 1902 must still rank as an exceedingly quiet year. The mean daily spotted area has increased markedly over that for 1901, being very nearly double; between 50 and 60 millionths of the Sun's visible disk as compared with 29 for 1901, but falling much short of the 75 registered in 1900. The number of separate groups has increased in an even larger proportion than the mean area, being 37 as against the 15 of 1901. The principal groups of the earlier part of the year were three in number. The first of these ran its course from January 5 to January 15, and was a group of the type which increases in actual as well as in apparent size the more fully it is presented towards the Earth. The second, seen from March 3 to March 14, was the largest group of the year. The third, from May 24 to June 4, was much smaller. The intervals between these times of disturbance were very quiet; from March 15 to May 4 inclusive, a period of 51 days, no spots were observed, and from June 5 to September 17 it was only occasionally that spots were seen, and these were always very small, faint, and short-lived. But the appearance of a new group on September 18 marked the commencement of a more regularly active period, more than half the groups of the year appearing on or after that date; and though these later groups never equalled that of March 3–14 in size, there has been scarcely a day from September 18 to the date of this report when the sun has been wholly free both from spots and from faculæ.

The faculæ in 1902 have shown a much more unmistakable increase than the spots. Their mean daily area had fallen from 337 in 1899, and from 180 in 1900, to 29 in 1901, but in 1902 it reached practically the same level as in 1900. M. Guillaume, from the observations made at the Lyon Observatory, indeed puts the total faculous area higher than in 1900; viz. 97·5 thousandths of the visible hemisphere in 1902 as against 81·2 in 1900; whilst the number of distinct groups was 363 in 1902 as compared with 210 in 1901, and 134 in 1900.

The distribution of spots in heliographic latitude has also been characteristic of the beginning of a new cycle. Most of the groups have formed between the 20th and 30th parallels; one group very nearly on the 40th. But three or four groups have been seen much nearer the equator; notably the first group of the year, that of January 5 to 15, which had its centre in S. latitude 8°.

The distribution of the faculæ in latitude has not altered much since the preceding year. M. Guillaume's figures show that there was a remarkable change from 1900 to 1901; only 20 per cent. of the groups having a higher latitude than 40° in the former year, whilst more than 40 per cent. exceeded that latitude in the later. This proportion was almost exactly preserved in 1902.

Of the two hemispheres the northern was much the more active in 1902, so far as sun-spot area is concerned; M. Guillaume's figures showing almost exactly double the area for the north as for the south; 1177 millionths, as against 594. The faculæ were more equally divided; out of 363 groups, 189 appearing north of the equator, and 174 south of it.

Looking back over the cycle just past, it would seem to have been decidedly above the average in length, the middle of the depression with which it began falling about 1889·3, and the middle of that with which it terminated about 1901·8, so that its entire duration was 12·5 years. The period of increase was about 4·3 years and that of decrease 8·2 years, the maximum falling about 1893·6. E. W. M.

The Prominences.—A slight reduction in the mean daily number for the southern hemisphere is shown by the observations made at Kenley during 1902 compared with the previous year.

The figures derived from ninety days of observation in 1901 and eighty-nine days in 1902, are as follows:—

	1901, Per Diem.	1902, Per Diem.
North hemisphere	2·56	2·69
South ,, ...	3·06	2·69
Total mean number	5·62	5·38

The two hemispheres would thus appear to have been reduced to exact equality as regards numbers produced; the southern prominences, however, have exceeded the northern in size, being on the average 6 per cent. larger.

The distribution in latitude has closely followed that in the previous year; thus in each hemisphere there is shown a strongly marked zone of activity, situated roughly between the parallels of 50° and 60°, and two less well-defined and far less active zones in lower latitudes. The limits of the zones of maximum activity are indicated at about 65° north and south, or 5° nearer the poles than was the case in 1901.

A few small and transient eruptions have occasionally been seen in the otherwise barren polar regions.

Speaking generally, the year appears to have been an extremely quiet one. No large eruptive prominences have been recorded, and only one metallic prominence. This was on January 19, in south latitude 30°, and, as so frequently happens, the reversals of the magnesium lines could be traced near the same position in the chromosphere after an entire rotation, viz. on February 15. J. E.

Determination of the Solar Motion.

The last reports of the Council referring to the progress made towards the determination of the direction of motion and velocity of the solar system were in 1891 and 1892, when attention was called to the following researches :

Dr. Stumpe, *Astron. Nach.*, Bd. 156, No. 3000.
Prof. Boss, *Astron. Jour.*, Nos. 195 and 196.
Prof. Porter, *Trans. Obs. Cincinnati*, No. 12.
Prof. Vogel and Dr. Kempf, *Astr Nach.*, Bd. 132, No. 3150.

During the ten years which have elapsed since these reports a good deal of attention has been given to this subject, both on the theoretical and the practical side. The methods employed have been criticised and elucidated, the available material has been increased by the determination of new proper motions of stars, and the old material has been improved by the more accurate determination of the systematic errors of the catalogues used in the determination of proper motions. In addition the linear velocity of the solar system has been obtained with greatly increased accuracy by new determinations of velocities of stars in the line of sight. Among the many astronomers who have touched on these questions during the last decade the names of Boss, Campbell, Kapteyn, Kobold, Newcomb, Porter, Ristenpart, and L. Struve are specially prominent.

The three best known methods of finding the solar motion are those of Airy, Argelander, and Bessel, to which was added, in 1900, another by Prof. Kapteyn.

(*a*) Airy's method is the most direct and the most simple in practice. The observed proper motions of each star furnish two equations of condition for the parallactic motion of the Sun resolved in three directions at right angles. Each equation involves errors due to observation and also the *motus peculiaris* of the star. If the distances of the stars were known these equations might be solved on two suppositions : (i.) that the irregularities were all due to errors of observation, or (ii.) to the *motus peculiares* of the stars, and the weights adopted in forming the normal equations would be different. As, however, the distances are not known, the equations are solved as they would be were all the stars at the same distance from the Sun.

The other methods adopted all aim at eliminating these unknown distances.

(*b*) In Argelander's method the direction of the solar apex indicated by the stars in a small area of the sky is considered to be the mean of the directions indicated by the individual stars, so that each star thus furnishes one equation.

(*c*) In Kapteyn's method the direction of the solar apex indicated by the motions of the stars in any small area of the sky is considered to be that which makes the sum of the resolved velocities in a perpendicular direction zero.

(*d*) Bessel's method consists in determining the poles of the directions of the proper motions of the stars, which would, if the solar motion were the only cause of these proper motions, lie on a great circle perpendicular to the direction of the solar motion. The circle is therefore drawn which best collects the various poles of the observed proper motions.

In the application of these methods different normal equations arise, as is shown by Prof. Kapteyn. He points out that the methods of Airy, Argelander, and Bessel will give better results when the equations of condition are formed from the means of all the stars grouped in small areas than when formed singly for each star. When this is done the results found by Airy's, Argelander's, and Kapteyn's methods will not differ much. He also does not consider it legitimate to group the stars according to their proper motions in the application of Airy's method as usually made, and attributes the regular change found by Stumpe in the declination of the apex when proper motions are grouped in this manner to an inherent defect in the method. In reply to criticism on his criticism of Airy's method, Prof. Kapteyn makes it clear that Airy's method applied to proper motions in *two* directions will lead to the same equations as his own method, and that his criticism of Airy's method is directed only against its separate application to right ascensions and declinations.

In this connection Prof. Boss may be quoted, who arrives at the conclusion that the great majority of the stars of the seventh magnitude or brighter will be included between relative distances 1·0 and 3·0, and under these circumstances the theoretical objections against the very convenient method proposed and illustrated by Airy practically disappear.

An approximate determination of the solar motion by a statistical method is given by Prof. Newcomb which illustrates the inherent difficulties of the problem in a forcible and extremely instructive manner. It is shown how widely the actual distribution of proper motions differs from the normal distribution of the law of errors, and it is pointed out that the best results are to be obtained by diminishing the weights of the more discordant motions. Prof. Newcomb exemplifies his method of rejecting the discordant observations in his discussion of the proper motions of the Bradley stars to give the precession and the solar apex. Out of 3181 stars he rejects 654, or a little more than one fifth.

Dr. Kobold's determinations are on a different footing from the others, as he has used Bessel's method. Applying this method to the proper motions of Auwers-Bradley, he found for the declination of the apex of the solar motion $D = -3°$, whereas Airy's and Kapteyn's methods give in different hands values ranging about $D = +30°$. Dr. Kobold obtained a similar result from 523 southern stars taken from Dr. Auwers' Fundamental Catalogue, and in a still later paper, in which he used proper motions of 1709 well-distributed stars, he obtained D = −0°·2, but obtains the more satisfactory result D = + 16°·5, when he takes the means for all the stars in the same part of the sky, and does not treat each star separately. The method is certainly open to the grave objection that a change of 180° in the direction of the motion of a star does not affect the result if each star is taken by itself, and it is not easy to separate the direct and retrograde motions. According to Mr. Everet Yowell (*A. J.*, No. 479), who applied Dr. Kobold's method, entirely different results were obtained, according as different approximate positions were assumed at the start. The method is also considered in a brief note by M. Radau (*Bulletin Astron.* tom. x. p. 401).

Dr. Ristenpart's determination of the solar motion forms part of a large paper in which the distribution of the stars in space and value of the precessional constant are also considered. The stars he uses for precession and solar motion are between the limits of 20° and 25° N. Dec., and the Berlin observations made about 1880 are compared with those of Bessel made at Königsberg about fifty years earlier. He uses Airy's method, and considers in his equations a possible rotation of the stars about an axis perpendicular to the plane of the Milky Way. He divides the stars into four classes and obtains results from each class.

Class.	Mean p.m.	Mean Mag.	No. of Stars.	M.	A.	D.
	″	m		″	°	°
I.	0·374	7·98	85	·279	286	31
II.	0·197	8·13	221	·109	275	44
III.	0·128	8·08	148	·061	255	23
IV.	...	...	4565	·027	267	20

where M is the parallactic motion of a star 90° from the apex, and A and D are the R.A. and Dec. of the apex.

Professor Newcomb by the use of Airy's method finds from the Bradley stars the following results :—

Stars of Small Proper Motion.

Mag.	No. of Stars.	M.	A.	D.
		″	°	°
1–2·9	64	·659	263·1	31·7
3–3·9	135	·561	262·7	26·8
4–4·9	327	·347	266·5	31·8
5–5·9	731	·314	268·5	32·0
6–6·9	1034	·281	277·4	30·6
7–	236	·286	278·2	33·6

Stars of Larger Proper Motion.

All mags.	644	1″·67	276°·9	31°·4

As a conclusion from his own and other work to 1899 he gives A = 18^h 30^m, D = + 35°, as the most probable position of the solar apex.

Professor Porter's new determination differs from his previous one in his adoption of systematic corrections to the catalogues from which he derived his proper motions, in the use of additional stars, and in the employment of Kapteyn's method. He finds

Class.	Proper Motion.	No. of Stars.	A	D.
	"		h m	°
I.	<0·2	1037	18 45	54·1
II.	0·2–0·5	1063	18 37	39·6
III.	0·5–1·25	235	18 25	34·4
IV.	>1·25	56	18 13	43·5

Professor Porter gives little weight to Classes III. and IV., and gives a double weight to Class I. on the ground that these stars are, judging from their mean proper motions, twice as distant as those of Class II., and therefore more widely scattered in space and less likely to be affected by any local drift. As a final result from 2000 stars he gives A = 18^h 42^m, D = 49°·3.

Professor Kapteyn included in the same paper a determination of the solar apex of the value of the precessional constant and the corrections required by the proper motions in declination of Auwers-Bradley. He uses 2640 stars, rejecting the *Hyades* and *Pleiades* groups and the stars observed in one coordinate only by Bradley. He also makes a determination from 699 stars of large proper motion taken from Professor Porter's catalogues, excluding the stars within 30° of the assumed position of the apex. He employs three different methods: (i.) statistical, (ii.) his own explained above, and (iii.) Airy's; and he also groups the stars in several different ways, according to the magnitude of the proper motion, the magnitude, and the spectral type. He obtains, for the precessional constant and the corrections to the proper motion of Auwers-Bradley, results in close agreement with Newcomb.

The results obtained by the several methods are in good agreement, the results being

		No.	A.	D.
			h m	°
Bradley Stars	...	2640	18 8	+ 28 4
Porter's Stars	...	699	18 31	+ 32 7

He concludes for the most probable position

A = 18^h 14^m D = + 29°·5

Professor Boss' paper, "Tentative Researches upon Precession and Solar Motion," contains many valuable remarks on the general problem. He states as the result of his own studies that the best point of attack is offered by the stars brighter than

$7^{\mathrm{m}}{\cdot}0$, after excluding stars having centennial proper motions greater than 10″, and perhaps also stars of magnitudes above the fourth. The determination of the parallactic motion which he gives in this paper is derived from a comparison of the Cape Catalogues for 1850 and 1880. Systematic corrections are applied to the right ascensions according to the conclusions of a paper by Professor Boss in *A. J.* No. 499. The number of stars employed is 3587, extending from the Equator to the South Pole. These are grouped into fifty-seven trapeziums, containing a number of stars varying from 10 to 223. Weights from one to six are assigned to the equations of condition arising from the separate trapezium, so as to allow for the accidental error, the probable amount of the residual systematic error, the effect of star drift, &c. Normal equations are formed separately for the right ascensions and declinations Airy's method being employed.

The results obtained are :—

	M.	A.	D.
	″	°	°
From Right Ascensions ...	·043	269·3	42·7
,, Declinations	·039	251·4	48·5
,, both	·041	263·7	45·9

As Professor Boss states, the two weak points in this determination are : (i.) the short interval of time between the catalogues, (ii.) it relates only to one hemisphere. To overcome the second objection Professor Boss revises the determination made by Dr. L. Struve by applying corrections to make it agree with Newcomb's system of right ascensions and Boss' system of declinations, and obtains as a result $A = 267^{\circ}{\cdot}0$, $D = 42^{\circ}{\cdot}8$. The rest of the paper, as far as it relates to solar motion, is a *résumé* of other investigations, and the most probable position is given as

$$A = 18^{\mathrm{h}}\ 20^{\mathrm{m}} \qquad D = +\ 45^{\circ}$$

Dr. L. Struve, in view of the differences found by Professor Newcomb and himself in the constant of precession, using the same material re-examined his previous work on the precession and solar motion. Some corrections depending on the right ascensions are applied to the declinations, differences are made in the weighting, and a number of stars excluded. The final result is, however, only slightly altered, being

$$A = 18^{\mathrm{h}}\ 20^{\mathrm{m}} \qquad D = +\ 23^{\circ}{\cdot}5$$

The differences in the declination of the solar apex found by L. Struve, Newcomb, and Kapteyn and Boss from the proper motions of Auwers-Bradley are almost entirely caused by the systematic corrections applied to the declinations of Bradley. Struve applied nothing, Newcomb and Kapteyn a correction which amounted to $-0''{\cdot}8$ for stars near the Equator, and Boss one of $-1''{\cdot}7$.

Professor Campbell's preliminary determination of the motion of the solar system is made from the extremely accurate values for the velocities in the line of sight obtained at the Lick Observatory. He has observed 280 stars, and deduces

$$V = -20 \text{ kilometres per sec.}$$

$$A = 18^{h}\,30^{m} \quad D = +20^{\circ}$$

The determination of the velocity by this method is much more accurate than one which can be deduced from the proper motions of stars whose parallaxes are known, and is a result which will only be improved by further spectroscopic observations. The agreement of the position of the apex with that deduced from proper motions seems extremely close, especially as there were no observations south of Dec. −30, and only few between −15° and −30°. Professor Campbell finds for the average velocities of the stars in the line of sight a remarkable progression with their magnitudes.

No. of Stars.	Mag.	Average Velocity. km.
47	$>3^{m}{\cdot}0$	13·05
112	$3^{m}{\cdot}1$ to $4^{m}{\cdot}0$	16·15
121	$<4^{m}{\cdot}0$	19·44

Professor Campbell comes to the conclusion that the faint stars are moving faster than the bright ones, and remarks that this profoundly affects the question of methods of determining the structure of the sidereal universe.

The following are references to the papers referred to in the above report, though a number of shorter papers and notes are to be found, especially in the *Astronomische Nachrichten.*

Boss ...	*Ast. Journal*, No. 501 (1901).
Campbell...	*Astroph. Journal*, xiii. p. 80–9 (1901).
Kapteyn ...	*Proc. Royal Acad. Sciences*, Amsterdam, vol. ii. p. 353 (1900), and vol. iv. p. 221 (1902). *Ast. Nach.* No. 3721 (1901), 3800 (1902). See also *Stein.* A. N. 3779.
Kobold ...	"Nova Acta der Ksl. Leop. Carol.," *Deutschen Akademie der Naturforscher*, Bd. lx. 15, No. 5. Halle (1895). *Ast. Nach.* 3163, 3451, 3591, and others
Newcomb.	"The Precessional Constant," *Astronomical Papers of the American Ephemeris*, vol. viii. Part I. (1897). *Ast. Journal*, No. 457 (1899).
Ristenpart.	*Karlsruhe Observations* (1892).
L. Struve.	*Ast. Nach.*, 3729 (1901), 3816 (1902).

F. W. D.

T

Investigations of Mr. E. T. Whittaker.

It has certainly been a welcome surprise to mathematicians to learn that the famous equation of Laplace admits of a general solution of quite a simple type. This has been shown by Mr. Whittaker in the *Monthly Notices*, vol. lxii. p. 617. He there proves the following theorem :—

"The general solution of Laplace's equation

$$\frac{\partial^2 V}{\partial x^2}+\frac{\partial^2 V}{\partial y^2}+\frac{\partial^2 V}{\partial z^2}=0$$

is $$V=\int_0^{2\pi} f(x\cos v+y\sin v+iz,\ v)\,dv,$$

where f is an arbitrary function of the two arguments $x\cos v+y\sin v+iz$ and v."

From this Mr. Whittaker has shown that the general solution of the differential equation of wave motions, namely,

$$\frac{\partial^2 V}{\partial x^2}+\frac{\partial^2 V}{\partial y^2}+\frac{\partial^2 V}{\partial z^2}=k^2\frac{\partial^2 V}{dt^2},$$

can be analysed into simple plane waves.

It is further proved that "distributions of simple waves exist such that, although each individual wave is periodic with respect to the time, yet the total disturbance at any point does not vary with the time." As for all such distributions the total disturbance can always be represented by a solution of Laplace's equation, we have the most interesting suggestion of an undulatory explanation of gravity. The conclusion of Mr. Whittaker's paper is as follows :—

"This undulatory theory of gravity would require that gravity should be propagated with a finite velocity, which, however, need not be the same as that of light, and may be enormously greater."

"Of course this investigation does not explain the *cause* of gravity ; all that is done is to show that the propagation across space of forces which vary as the inverse square of the distance does not require for its explanation any other property of the medium than one which has long been known and accepted."

R. S. B.

Nova Persei.

Interest in *Nova Persei* during the year has been mainly concentrated on the beautiful photographs obtained by Mr. Ritchey at the Yerkes Observatory, and by Mr. Perrine at the Lick Observatory. These photographs, which are given in the

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Astrophysical Journal, show rings in which there are separate condensations which show large individual motions and in general not radial. The *Astrophysical Journal* and the *Astronomische Nachrichten* contain numerous papers as to the explanation of these phenomena, and, as a result, there seems to be a general consensus in favour of Kapteyn's explanation that finely divided matter having the observed structure is illuminated by light waves emanating from the Nova.

Several attempts have been made to determine the parallax of the Nova. The photographic determinations have resulted in a negative value of the order of $-0''\cdot10$. This is explained by Dr. Bergstrand as due to atmospheric dispersion, and with an allowance for this he obtains the result of $+0''\cdot033$. Dr. Chase, as the result of heliometer measures, has obtained the value $-0''\cdot02$, so that the parallax determinations may be said to confirm Dr. Max Wolf's parallax of $0''\cdot012$, derived on the assumption that the luminosity of the nebula was caused by a wave travelling with the velocity of light. Micrometric measures made by Professor Perrine and Professor Barnard agree with photographic results in showing that the proper motion of the Nova is extremely small. The Nova has diminished about three magnitudes during the year from $7^{\mathrm{m}}\cdot0$ to $10^{\mathrm{m}}\cdot0$. Isolated observations of the magnitude are to be found in the astronomical journals, but no general discussion has yet been published. A table has been published by Professor Pickering for converting the estimates of magnitude of the neighbouring stars given by Father Hagen to a photometric scale.

Professor Pickering has found a star of the thirteenth or fourteenth magnitude close to the present position of the Nova on a number of plates taken between 1890 October 26 and 1900 March 7, the differences of R.A. and Dec. as obtained from measures made on three of these plates being

$$\left.\begin{array}{llll} \Delta\alpha & -1''\cdot6 & +1''\cdot2 & +0''\cdot2 \\ \Delta\delta & +1\cdot3 & -1\cdot0 & -1\cdot2 \end{array}\right\}$$

It seems probable that this is the coincident with the small star which M. Ceraski found on photographs before the outburst of the Nova. As Professor Barnard points out, now that *Nova Persei* is diminishing in brightness, it will soon be possible to see whether this faint star still exists in the neighbourhood. If not, then it is probable that the Nova is identical with this star. The star found by Professor Pickering was variable to the extent of half a magnitude, and it will be of interest to observe whether the Nova will descend again to the condition of a slightly variable star of between the thirteenth and fourteenth magnitudes.

F. W. D.

Double Stars.

The arrangement of this report is that adopted for some years, the work being referred to under the heads, "Observation" and "Calculation." Abbreviated titles have been used as follows :

M. N. : *Monthly Notices, R. A. S.*
M. R. A. S. : *Memoirs, R. A. S.*
A. N. : *Astronomische Nachrichten.*
A. J. : *Astronomical Journal.*
A. S. P. : *Astronomical Society of the Pacific.*
L. O. B. : *Lick Observatory Bulletin.*
Obs. : *The Observatory.*
B. A. A. : *Publications of the British Astronomical Association.*

Observation.—Measures of some stars of special interest will be found :—

Sirius ...	R. G. Aitken, *A. S. P.* 84. W. Hussey, *A. S. P.* 84.
δ *Equulei*...	R. G. Aitken, *A. S. P.* 87. W. Hussey, *A. S. P.* 87. W. W. Bryant, *M. N.* 1902 March. T. Lewis, *M. N.* 1902 March.
κ *Pegasi* ...	T. Lewis, *M. N.* 1902 March. W. Bryant, *M. N.* 1902 March.

New Double Stars—

W. J. Hussey. *L. O. B.* 21. Fifth Catalogue, 100 new doubles, 60 of which are under 1″·0 separation.

W. J. Hussey. *A. S. P.* 87. Unusual triple star, components of nearly equal magnitude, forming an equilateral triangle (side 1″·5).

Rev. T. E. Espin. *A. N.* 3784. Seventy-two new doubles.

R. G. Aitken. *A. S. P.* 82. Principal component of Σ 238 found to be a close double.

R. G. Aitken. *A. S. P.* 86, 83 *Aquarii* found to be a close double.

R. G. Aitken. *A. N.* 3784. Fourth list of new doubles (109).

F. Küstner. *A. N.* 3821, 66 new double stars.

Measures of Known Pairs—

R. G. Aitken. *A. S. P.* 86. Measures of the double Aitken 88. Rapid binary.

F. Küstner. *A. N.* 3821. Measures of 30 pairs.

R. T. A. Innes. *M. N.* 1902 April. Cape double star results, 1901.

R. T. A. Innes. *M. N.* 1902 December. Cape double star results, 1902.

Rev. T. E. Espin. *M. N.* 1902 March. Measures of Σ 484 and Σ 485.

Rev. T. E. Espin. *M. N.* 1902 May. Micrometer measures of double stars with the $17\frac{1}{4}$-inch reflector.

E. A. Boeger. *A. J.* 522. Measures of 70 pairs, mostly Σ, made with the 12-inch Washington refractor.

Dr. Jedrzejewicz. *A. N.* 3802. Measures of 25 Struve pairs made in 1887.

John Tebbutt. *M. N.* 1902 April. Micrometer measures of double stars made at Windsor, N.S.W.

E. E. Barnard. *M. N.* 1902 March. Micrometrical observations of Nova *Cygni.*

H. Thiele. *A. N.* 3837. Measures of 41 pairs by photography, distances ranging from 1″·11 to 10″·99.

Royal Observatory, Greenwich. *M. N.* 1902 March. Results of micrometer measures of 400 stars made with the 28-inch refractor in 1901.

W. Doberck. *A. N.* 3798–99. Measures of double stars made at Hong Kong in 1901 and part of 1902.

W. H. Maw. *M. R. A. S.* vol. liv. Double star measures made 1899 to 1901 with 6-inch and 8-inch refractors.

Calculation, &c.—The following papers dealing with calculation and general literature have appeared in the course of the year :

β 151 ...	R. G. Aitken, *A. S. P.* 86. Orbit, period 27·66 years.
Σ 1757, Σ 1785 Σ 1837, Σ 1863	T. Lewis, *Obs.* No. 320. Discussion of measures and general notes on.
Σ 1883, Σ 1989 Σ 2021, Σ 2052 Σ 2402, Σ 2434	T. Lewis, *Obs.* No. 321. Discussion of measures and general notes on.
Σ 2900, Σ 2944 Σ 3041, Σ 3050	T. Lewis, *Obs.* No. 324. Discussion of measures and general notes on.
θ *Orionis* ...	F. Comas Solá, *A. N.* 3793. Note on and measures of.
η *Geminorum*	Miss A. M. Clerke, *Obs.* 324.
,,	W. Campbell, *L. O. B.* 20. Variable motion in line of sight.
ζ *Herculis* ...	W. Campbell, *L. O. B.* 20. Variable motion in line of sight.
,,	P. Lowell, *A. J.* 527, ditto.

W. Hussey. *Obs.* No. 322. "On the measurement of close double stars."

L. de Ball. *A. N.* 3774. "On the influence of parallax, aberration, P.M., and refraction on the position-angle and distance of two fixed stars."

Gavin J. Burns. B. A. A. Vol. xii. No. 6. "Distribution of double stars in space."

Dr. Doberck. A. N. 3791. "The distribution of Binary Stars."

E. Holmes. B. A. A. Vol. xii. No. 7. "Distribution of double stars in space."

Variable Stars.

Since the last report the following twenty-three new variable stars have been announced :

Provisional Notation.			R.A.		Decl.		Epoch.	Discoverer.	Reference &c.
			h	m	°	′			
97	1901	Velorum	9	24·8	−51	38	1875	Cape	Ann. Report
98	1901	Carinæ	11	14·2	−61	10	1875	,,	,,
99	1901	Capricorni	20	25·3	−22	7	1875	,,	,,
1	1902	Cygni	20	50·4	+29	53	1855	Williams	*A. N.* 3771
2	1902	Lacertæ	22	41·8	+54	24	1855	Backhouse	,, 3792
3	1902	Monocerotis	6	50·6	+ 6	21	1855	Mme. Ceraski	,, 3775
4	1902	Geminorum	7	32·6	+20	45	1855	,,	,, 3782
5	1902	Lyræ	18	56·2	+37	19	1855	Williams	,, 3783
6	1902	Draconis	18	5·1	+65	57	1900	Greenwich	*M. N.* Mar. 1902
7	1902	,,	18	6·9	+66	9	1900	,,	,,
8	1902	Camelopardi	5	49·4	+74	31	1900	,,	,,
9	1902	Nil							*A. N.* 3799
10	1902	Cygni	21	55·2	+43	52	1900	Harvard	*H. C.* 65
11	1902	Lyræ	19	7·6	+41	4	1855	Williams	*A. N.* 3796
12	1902	Pegasi	22	5·2	+13	50	1855	Graff	,, ,,
13	1902	Lyræ	19	10·8	+32	10	1855	Williams	,, 3811
14	1902	Persei	2	30·8	+41	34	1855	,,	,, 3820
15	1902	Delphini	20	34·7	+11	21	1855	Anderson	,, 3821
16	1902	,,	20	26·0	+16	57	1855	Mme. Ceraski	,, 3830
17	1902	Lyræ	18	40·8	+43	29	1855	Williams	,, 3831
18	1902	Coronæ	16	10·3	+38	8	1855	Anderson	,, ,,
19	1902	Pegasi	21	57·8	+34	25	1855	,,	,, ,,
20	1902	Cygni	21	0·7	+45	12	1855	Mme. Ceraski	,, 3833
21	1902	Sagittæ	20	13·8	+20	39	1855	,,	,, 3836

Notes.—Nos. 97, 99, 3, 5, 11, 17, 19, 21 :—Long-period variables. No. 1 :—Cluster-type, per. $13^{\mathrm{h}}{\cdot}4$. No. 2 :—Independently found by Graff, *A. N.* 3774. Nos. 6, 7, 8 :—Found during the measurement of the *Carte du Ciel* plates. Nos. 10, 13, 14, 20 :—*Algol*-type variables, No. 10 having the long period of $31^{\mathrm{d}}{\cdot}304$.

The large proportion of new *Algol* type variables is noticeable.

The number of papers containing observations and discussions of variable stars which have appeared during 1902 is very large, some paper or papers having appeared in nearly each number of every astronomical publication. We may mention here that the Commission of the *Astronomische Gesellschaft*, charged with the preparation of a new variable star catalogue, has issued two lists containing the definitive nomenclature and positions of those stars certainly recognised as variable since the appearance of Chandler's third catalogue. The first list contains 194 stars, and appeared in *A. J.* 514; the second list of 24 stars is in *A. J.* 524. These lists will also be found in the *A. N.* 3752 and 3809.

The usual very complete ephemerides for 1903 of variable stars have been issued by Prof. E. Hartwig in part 3 of the *V. J. A. G.* for 1902. These include maxima or minima of the variables north of −23° in one table, and south of −23° in another, both arranged according to R.A. Another table gives maxima and minima arranged according to date. A third part is devoted to the heliocentric minima of the *Algol*-type stars, whilst a final table gives the maxima of the *Antalgol*-type variables *Y Lyræ* and *UY Cygni.* Less complete tables, but ample for many observers' purposes, are published in the *Companion* to the *Observatory*, and in the *Annuaire du Bureau des Longitudes.*

The fourth report of the Variable Star section of the British Astronomical Association was issued in 1902 June by Colonel E. E. Markwick, the director of the section; it is, however, confined to observations of Nova *Persei.*

In October Mr. Packer observed *α Orionis* (*Betelgeuse*) to be brighter than *Capella.* Dr. Copeland circulated the news by an Edinburgh telegram. The announcement excited wide interest, and many observations, visual and photographic, have already been published.

Dr. A. W. Roberts, of Lovedale, C.C., has a paper on 'Certain Considerations regarding *Algol*-variation, with special reference to C.P.D. −45°, 4511 in *Proc. Roy. Soc. Edin.* vol. xxiv., part 2. In this paper Dr. Roberts develops and applies a method of finding the dimensions of *Algol*-systems. A paper by Mr. J. Baxendell on "Pogson's Madras Observations" appeared in *A. J.* 520.

In our last report mention was made that Dr. Chandler had announced (*A. J.* 492) that, owing to the pressure of other work, he would not be able to issue a fourth edition of his catalogue of variable stars. The task of preparing a new catalogue has therefore been taken up by a commission of the *Astronomische Gesellschaft*, consisting of Messrs. Dunér, Müller, Oudemans, and Hartwig. A preliminary report has been published by Prof. G. Müller. He remarks that since Chandler's catalogue of some 400 objects was published in 1896 more than 200 new variables have been discovered. It is the Commission's wish to issue—

as for the beginning of a new century—as complete a representation of our knowledge of variable stars as possible. It is, therefore, purposed to divide the catalogue into several divisions :—Part I. will contain only certainly determined variables ; Part II. is for doubtful objects or those requiring further observation ; Part III. will be reserved for variables in star-clusters. It is pointed out that such clusters as ω *Centauri* containing over 100 known variables make such a division very desirable if not absolutely necessary ; Part IV. and last is to be reserved for "New Stars" which are hardly to be reckoned as variables. It is also proposed to add to the catalogue a collection of auxiliary tables which will be useful to variable star observers and calculators, such as a table of Julian days and tables for the reduction to heliocentric time of *Algol*-type variables. It is the intention of the Commission to include no star in their catalogue which, if a photographic variable, has not an amplitude of variation of one whole magnitude, whilst for visual observations the minimum range will be half a magnitude. It will only be in quite exceptional circumstances that variables with a smaller range will be admitted. Even so, it is estimated that the new catalogue will contain between 600 and 650 variable stars. In Chandler's catalogues the notes were necessarily exceedingly brief ; it is the intention of the Commission to make a radical change in this. They purpose not only giving a short history of each star, but a full description of the form of light-curve and its irregularities if any, as well as a complete index to all the published observations and investigations of period &c. which are of any importance. The Commission are aware of the great increase this will make in their work, but believe it will meet with the approval of astronomers. This index will at once show the practical astronomer the state of our knowledge regarding each star, and thus it will be easy to pick out stars requiring further observation. They specially recommend to young astronomers the observation of such stars as require new observations and offer their advice on the choice of such. The catalogue will be printed in the quarto size of the *Astronomische Gesellschaft* publications. The Commission are now busily engaged on the index and the rediscussion of all the old observations, and hope that in a year's time the conclusion of their task will be in view. They are asking the *Astronomische Gesellschaft* for a grant of 2000 marks in aid of the routine work. R. T. A. I.

Stellar Spectroscopy in 1902.

Spectrum of Nebulæ.—Messrs. Scheiner and Wilsing in their paper in *Ast. Nach.* **159**, 181 (abstract in *Astroph. Jour.* xvi. 234) give the results of their determination, by means of a spectrophotometer, of the relative intensities of the three chief nebular lines at wave-lengths 4861, 4959, and 5007 in nine nebulæ ; and they arrive at the conclusions that (1) in the nebulæ examined the ratio of the brightness of the lines 5007 and 4959 is constant, but (2) that of the lines 5007 and 4861 varies considerably (thus confirming Keeler's results); (3) the hydrogen (4861) line is relatively brighter in the *Orion* nebula than in any of the other nebulæ examined, the intensity ratio of 5007 to 4861 ranging from 40 : 1 in *N.G.C.* 6790 to 11 : 1 in the *Orion* nebula; (4) the question of the constancy of the intensity ratio of the nebular lines in different parts of the *Orion* nebula has not received further definite elucidation by the measures made hitherto. With regard to the last named point it would seem that, in the light of the first three conclusions of Messrs. Scheiner and Wilsing, constancy in a widely extended nebula would be more difficult of explanation than variation. It is to be hoped that the authors may be able to deduce from their observations a first approximation to the brightness of, let us say, the first nebula line 5007 in the various nebulæ which they have examined.

A contribution to our knowledge of the spectrum of nebulæ comes from the Lick Observatory (*Bulletin* No. 19, and *Astroph. Jour.* xvi. 52). Mr. Wright has determined the wave-lengths of 19 of the brighter nebular lines between 3726 and 5007 from observations of four nebulæ.

Spectrum of New Stars.—The following papers have been published relating to *Nova Persei*:

Lockyer ...	*Proc. R. S.* lxix. 354.
Sidgreaves ...	*M. N. R. A. S.* lxii. 137 and 521.
„ ...	*Ast. Nach.* **157**, 197.
Von Gothard ...	„ „ **157**, 141.
Merecki ...	„ „ 158, 43.
Love	*M. N. R. A. S.* lxii. 524.
Wright ...	„ „ lxii. 630.

Classification of Stellar Spectra.—The interesting address made by Professor Schuster to the Royal Philosophical Society of Glasgow is published in the *Proceedings* of that Society. Under the title "The Evolution of Solar Stars" he gives a broad and very suggestive contribution on various points bearing on classification.

The Solar Physics Committee have issued a Catalogue of 470 of the brighter stars classified according to their chemistry at the Solar Physics Observatory, under the direction of Sir Norman Lockyer.

A brief summary of the various systems of classification hitherto proposed is given by Professor G. E. Hale in the New Supplement of the *Encyclopædia Britannica*, vol. 32, under "Spectroscopy."

Velocity in the Line of Sight.—A plan of co-operation between 8 or 10 observatories engaged in spectroscopic determinations of radial velocity of stars has been inaugurated by the initiation of Professor E. B. Frost, of the Yerkes Observatory, primarily with the view of arriving at definitive values for the velocity of certain selected stars. We may hope that the co-operation, which in the nature of the case is necessarily of an international character, will lead to further developments in a systematic advance in a branch of astronomy which is growing in scope and interest. (*Astroph. Jour.* xvi. 169.)

Mr. Adams gives (*Astroph. Jour.* xv. 214) the velocity of *Sirius* as $-6{\cdot}87\ ^{\mathrm{km}}/_{\mathrm{sec}}$ at the epoch 1902.06, as determined at the Yerkes Observatory.

Dr. Eberhard (*Ast. Nach.* **157**, 341) has studied the spectrum of the long period variable χ *Cygni* at the Potsdam Observatory, and finds that the shift of the bright lines suggests a velocity of $-20\ ^{\mathrm{km}}/_{\mathrm{sec}}$, whilst that of the absorption lines give a velocity of $+2{\cdot}4\ ^{\mathrm{km}}/_{\mathrm{sec}}$.

Dr. Hartmann (*Sitz. Berlin. Akad.* 1902, p. 237, and *Astroph. Jour.* xv. 287) has by photographic methods determined the radial velocity of three nebulæ whose spectra exhibit bright lines, viz. *G.C.* 4390, *G.C.* 4373, and *N.G.C.* 7027. His results accord well with those of the visual observations made by Keeler in 1890–91.

Dr. Vogel (*Sitz. Berlin. Akad.* 1902, p. 259, and *Astroph. Jour.* xv. 302) has searched for relative motion in different parts of the *Orion* nebula, and finds evidence of its existence. He points out that the differences of velocity found are for the most part smaller than those which Keeler considered detectable in his memorable investigations.

Variable Radial Velocity.—To the list of stars with variable radial velocity several additions have been made in the course of the year :

	α h m	δ ° ′	Period. d	Discovered.	Reference.
φ Persei	1 37	+50 11	...	Lick Obs.	Campbell, Lick Obs. *Bull.* 20 ; *Astroph. Jour.* xvi. 114.
ο Persei	3 38	+31 58	4·39	Yerkes Obs.	Adams, *Astroph. Jour.* xv. 214 : Vogel, *Sitz. Berl. Akad.* 1902, 1113
ε Aurigæ	4 55	+43 40	...	Potsdam	Vogel, *Sitz. Berl. Akad.* 1902, 1068.
η Geminorum	6 9	+22 33	...	Lick Obs.	Campbell, Lick Obs. *Bull.* 20 ; *Astroph. Jour.* xvi. 114.
δ Libræ	14 56	− 8 8	...	Yerkes Obs.	Adams, *Astroph. Jour.* xv. 214.
ζ Herculis	16 38	+31 47	...	Lick Obs.	Campbell, Lick Obs. *Bull.* 20 ; *Astroph. Jour.* xvi. 114 ; Lowell, *Astronomical Jour.* xxii. 190.

	α	δ	Period.	Discovered.	Reference.
	h m	° ′			
α Equulei	21 11	+ 4 50	...	Lick Obs.	Campbell, *Astroph. Jour.* xvi. 114.
β Cephei	21 27	+70 7	...	Yerkes Obs.	Frost, *Astroph. Jour.* xv. 340.
o Andromedæ	22 57	+14 47	...	Lick Obs.	Campbell, *Astroph. Jour.* xvi. 114.

Mr. Newall contributes a note (*M. N. R. A. S.* lxii. 124) on the velocity of *α Persei.*

New Instruments, &c.—A brief popular account, with illustration, of the new Mills reflector and spectrograph is contributed by Professor Campbell to the *Scientific American* for 1902 November 29. An expedition is to be sent from the Lick Observatory with this installation, under the charge of Mr. Wright, to Santiago (latitude 33° S.) for two or three years, and the photographs of spectra obtained in the survey will be sent to the Lick Observatory for measurement and discussion.

It appears, from a contribution to the *Astronomical Journal*, xxii. 190, that spectroscopic work has been begun at the Lowell Observatory.

Professor Scheiner (*Ast. Nach.* **160**, 369) describes a convenient arrangement for giving a comparison line of controllable brightness for measuring faint spectra.

Measurement and Reduction of Observations.—The following contributions have been made to the study of what may be called the right and left personality in measuring photographs of spectra :—

Hartmann, *Ast. Nach.* **155**, 81.
Reese, *Astroph. Jour.* xv. 142, and Lick Obs. *Bull.* No. 15.
Hasselberg, *Astroph. Jour.* xv. 208.

Mr. H. N. Russell (*Astroph. Jour.* xv. 252) has put the analytical method of computing the orbit of a spectroscopic binary into convenient form for taking account of terms of the second and higher order in the eccentricity. Dr. Wilsing (*Ast. Nach.* **134**, 90, 1893) had previously applied the method of developing the observed velocities in trigonometrical series to the investigation of an orbit of small eccentricity, such that terms above the first of the series in e were not required, viz. the orbit of *α Virginis.* Mr. Russell's note indicates how the method may be developed for more general application, not only so far as degree of eccentricity is concerned, but also in cases where observations fail at certain epochs because of peculiarities in the period. H. F. N.

Star Catalogues.

The Paris Catalogue.—M. Loewy announced to the Academy of Sciences in November last the completion of this catalogue. The observations extend from 1837 to 1881, and comprise 387,474 observations in right ascension and 221,369 observations in declination of 34,733 stars, and have taken M. Gaillot and M. Bossert twenty years to complete. The first volume $0^h - 6^h$ R.A. was published as far back as 1887.

Dr. N. M. Kam's Catalogue.—Some years ago Dr. Kam brought out a catalogue of stars the observations of which had been made in connection with the observations of comets and small planets &c., and had been published in various periodicals, notably in Band 1–66 of the *Astronomische Nachrichten.* This is a second catalogue, on the same lines as the first, based on similar observations published from time to time in Band 67–112 of the *Astronomische Nachrichten.* A great deal of human interest attaches to this volume. Only about a third of it was set up in type when Dr. Kam, after a short illness, died in March 1896; the rest of it has been completed under the direction of Professor H. G. van de Sande Bakhuyzen as a labour of love for his departed friend. The catalogue comprises 6460 stars brought up to the epoch 1875, with annual variation, secular variation, and the value of the third term, and a comparison wherever possible with some catalogue place.

Leiden Catalogue.—This is one of the catalogues brought out under the auspices of the Astronomische Gesellschaft, and consists of 10,239 stars between north declinations 27° 50′ and 35° 10′. The observations were made in the years 1870–1876 and 1880–1898. In the introduction is a discussion of the personal equation of the various observers for magnitudes, and at the end of the catalogue are tables of comparison with Lalande, Bessel, Struve, and Argelander. The publication of this catalogue now leaves only Dorpat to complete the original survey of the northern hemisphere as undertaken by the Astronomische Gesellschaft.

Catalogo di declinazioni medie pel 1900-0 *di* 1419 *stelle comprese nell' emisfero nord, osservate al circolo meridiano negli anni* 1895–99 *di A. Di Legge e F. Giacomelli.*—This catalogue is of declinations only, made at the Royal Observatory at the Campidoglio, and is remarkable for the fact that the places depend in nearly all cases on as many reflexion as direct observations, the results of both positions being given as well as the mean.

Resultate aus Beobachtungen von 560 *Sternen angeführt in den Jahren* 1897–1901 *am grosser Berliner Meridiankreise, nebst Ableitung der Eigenbewegungen von* 233 *Sternen von H. Battermann.*—This paper contains the computations of the proper motions of 233 stars, and the catalogue places of 560 stars reduced to 1900–0 from observations made at Berlin between 1897–1901 with the meridian instrument. W. G. T.

Latitude Variation.

'A New Annual Term in the Variation of Latitude, Independent of the Components of the Pole's Motion," is the heading of an article in *A. J.* 517, by Prof. Kimura, or, in other words, the Earth's centre of gravity may have an annual periodic oscillation of a few feet in the line of the axis. The basis of this assumption is as follows :—Professor Kimura, noticing that the residuals of the observations of some of the latitude variation stations showed certain periodicities, recalculated the variation of latitude on the assumption that

$$\phi - \phi_0 = \xi + x \cos \lambda + y \sin \lambda,$$

where ξ is variable with respect to time, but at any particular instant has a constant value for all stations. First of all this was done for ten stations between latitude 60° – 21° N. for the period 1899.8—1901.0, secondly from several series of observations in the preceding ten years. The resulting values of ξ for 0·1 of a year from the two discussions are :

Tenths of Year.	ξ (1).	ξ (2).	Tenths of Year.	ξ (1).	ξ (2).
	″	″		″	″
·0	+·031	+·021	·5	−·030	−·033
·1	+·023	+·020	·6	−·033	−·032
·2	+·015	+·017	·7	−·031	−·015
·3	+·002	+·006	·8	−·004	−·012
·4	−·015	−·012	·9	+·015	+·016

The remarkable accordance between these two determinations would seem to establish the reality of a term ξ the mean value of which will approximately correspond to a mean latitude of 42° N. The high precision of these Küstner-Talcott observations, and the enormous mass of them, precludes the idea that this is anything but an objective reality, and emphasises the fact of the great value of this enterprise, and of what can be done by well directed and concerted action. W. G. T.

The Astrographic Chart.

There are few circumstances to specially record in connection with the work of the Astrographic Chart and Catalogue. The first volume of the Catalogue of the zone allotted to the Paris Observatory has been published during the year, containing the

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rectangular coordinates, with the necessary plate constants, of 64,264 stars comprised in a zone two degrees broad whose centre is in declination +24°. M. Loewy has supplemented this publication by some general remarks on stellar photography and the accuracy of photographic measures which have given rise to a discussion which will be found in the *Monthly Notices.* The four French observatories have continued to make reproductions on paper by heliogravure of the Chart plates on a scale twice that of the original; the numbers of these already published are as follows:—Paris 142, Bordeaux 6, Toulouse 101, Algiers 104. The observatories of Rome and San Fernando are also making enlargements of this kind, and preparations have been made at Greenwich for making similar enlargements by photography.

The state of the work at some of the observatories may be learnt from their annual reports. The third volume of the catalogue of the Potsdam Observatory is in the hands of the printer. The rectangular coordinates of the first volume, which comprises half of the Greenwich zone, is printed but not published. The plates taken at the observatories of the Cape of Good Hope, Sydney, and Melbourne are being measured by means of filar micrometers, and it is believed that the measurement at most of the other observatories is proceeding. H. P. H.